D. REMARKS/ARGUMENTS

1. Status of the Claims

Claims 1 - 24 are currently pending in the application. Claims 1, 14, 15, 16, 17, 18, 19, 21, and 24 are independent. Claims 2-13 depend on claim 1. Claim 20 depends on claim 19. Claims 22-23 depend on claim 21.

2. Objection to the Specification

The Examiner stated: "The disclosure is objected to because of the following informalities: The acronym NMR is not defined . . . Appropriate correction is required."

In response, Applicant has revised paragraph [0003] of Applicant's specification, to include a definition of the acronym NMR, namely Nuclear Magnetic Resonance. <u>See</u> section B above.

Applicant submits that the Examiner's objection is now overcome.

3. Rejection of Claim 1 Under 35 U.S.C. § 112

The Examiner has objected to claim 1, under 35 U.S.C. § 112 ¶ 2, on the grounds that there is insufficient antecedent basis for the limitation ". . . and to generate the singular values . . . " in claim 1.

In response, Applicant has amended claim 1, to include antecedent basis for the limitation "singular values." In particular, Applicant has changed the phrase "the singular values" to the phrase "one or more singular values." <u>See</u> section C above. Applicant submits that this amendment was made solely to correct a minor technical informality, and that the reasons for this amendment have nothing whatsoever to do with the patentability of claim 1.

Applicant submits that the Examiner's objection to claim 1 under 35 U.S.C. § 112 is now overcome.

4. Rejection of Claims 1, 2, and 4-8 Under 35 U.S.C. § 103(a)

Claims 1, 2, and 4-8 stand rejected under 35 U.S.C. § 103 as being unpatentable over a IEEE Nuclear Science Symposium and Medical Imaging Conference paper titled "Application of DSP Techniques to Nuclear Magnetic Resonance Spectroscopy" by

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Worley ("Worley"), U.S. Pat. No. 5,453,940 to Broomhead ("Broomhead"), and U.S. Pat. No. 6,002,480 to Izatt ("Izatt"). Applicant respectfully traverses these rejections.

Applicant submits that, for the reasons discussed below, a *prima facie* case of obviousness of claims 1, 2, and 4-8 has not been established and therefore that there is no proper basis for a 35 U.S.C. § 103 rejection of claims 1, 2, and 4-8. See MPEP 2142 ("The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness.")

It is well known that, in order to establish a *prima facie* case of obviousness, a rejection must satisfy, *inter alia*, at least the following conditions:

A)   The prior art reference(s) must teach or suggest all of the elements and limitations recited in the claims; and

B)   There must be some suggestion, teaching, or motivation to combine the references on which the rejection is based.

See MPEP 2142.

Applicant submits that: 1) the cited documents Worley, Broomhead, and Izatt, either alone or in combination, fail to teach or suggest all of the elements and limitations recited in claims 1, 2, and 4-8, and that 2) the record does not establish the requisite suggestion, teaching, or motivation to combine Worley, Broomhead, and Izatt.

Claim 1

A.   The Cited Documents (Worley, Broomhead, and Izatt), Either Alone or in Combination, Fail to Teach or Suggest All of the Elements Of Claim 1

Applicant's claim 1, as currently amended in accordance with section C above, is reproduced below:

1.   An apparatus for performing spectral analysis, the apparatus comprising:

a.   a data acquisition system configured to measure a signal emitted from a sample in response to excitation energy applied thereto, and to average the measured signal over a plurality of measurements to generate an averaged signal;

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b.   a data processing system including:

a noise-reduction pre-processor configured to create a vector space from said averaged signal, and to generate one or more singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space, said vector space containing a noisefree signal subspace and a noise subspace, said singular values including noisefree singular values associated with said noisefree signal subspace, and noise singular values associated with said noise subspace; and

c.   a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.

Worley

Worley relates to the application of DSP techniques to NMR spectroscopy. Worley does not teach or suggest creating a vector space from an averaged signal that is generated by averaging over a plurality of measurements. Also, as acknowledged by the Examiner, nowhere in Worley is disclosed any control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, or to prevent further measurements if the appearance and stability of the gap can be established.

Specifically, Worley does not teach or suggest at least the following limitations of claim 1:

(1)   a data processing system including: a noise-reduction pre-processor configured to create a vector space from said averaged signal,

(2)   and to generate one or more singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space;

(3)   a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent

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further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.

Regarding element (3) above, the Examiner has acknowledged that Worley does not teach element (3). See Office Action, page 3 ("*Worley et al. does not teach a control system . . .*")

Worley also does not teach or suggest element (1) above. Col. 2, lines 11-13 in Worley, which were cited by the Examiner to support his position that Worley discloses element (1), refers to the research environment for the Worley document, not to the actual disclosure in Worley. Col. 2, lines 11-13 of Worley, appearing in the section entitled "*The Research Environment,*" states: "*A software platform is needed that encourages experimentation and gives researchers with medical backgrounds access to signal processing primitives without requiring specific knowledge of programming, specific algorithms, or theory.*" Nothing in Col. 2 lines 11-13 of Worley (quoted above) teaches or suggests any noise-reduction pre-processor configured to create a vector space from an averaged signal, which is generated by averaging a measured signal over a plurality of measurements.

Further, Worley does not teach or suggest element (2) above of claim 1, i.e. does not teach or suggest a noise-reduction pre-processor configured to generate singular values and eigenvectors of a correlation matrix constructed within a vector space that is created from an averaged signal. Col. 3, lines 18-19 of Worley states: "*These methods [Multiple Signal Classification method and Minimum Norm method] are based on eigendecomposition of the autocorrelation matrix of the random process.*" Col. 3, lines 18-19 of Worley, or elsewhere in Worley, does not teach or suggest that a correlation matrix be constructed within a vector space that is created from an averaged signal, where the averaged signal is generated by averaging a measured signal over a plurality of measurements.

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<u>Broomhead</u>

Broomhead relates to an analyzer for dynamical systems, not to an apparatus for performing spectral analysis. Broomhead does not teach or suggest any of the limitations of claim 1.

In particular, Broomhead relates to analyzing dynamic systems that may be mathematically nonlinear or chaotic, by creating a mathematical model used to predict future behavior of a dynamical system on the basis of preceding behavior of the system. (<u>See e.g.</u> Broomhead col. 1, lines 6-9, and col. 2, lines 12 - 18: *"This invention relates to a dynamical system analyser, and more particularly to such a device applicable to analysis of dynamical systems which might be nonlinear or chaotic in the mathematical sense. . . . The invention . . . produces a mathematical model of a dynamical system. . . a mathematical model created by the heuristic processing means may be employed to generate predictions of future dynamical system behaviour on the basis of preceding behaviour.*) Broomhead also teaches a singular value decomposition of a time series of signals from a dynamical system. (<u>See e.g.</u> Broomhead col. 2, lines 22 – 32: *". . . the invention provides a dynamical system analyser including: (1) means for deriving a time series of signals from a dynamical system, (2) means for generating from the time series a set of singular vectors . . . the set . . . corresponding to a subset of a set of vectors from a singular value decomposition of the time series . . . "*).

Applicant submits that not even a single one of the limitations of claim 1 is taught or suggested by Broomhead. In particular, Broomhead does not teach or suggest an apparatus for performing spectral analysis, or a data acquisition system configured to measure a signal emitted from a sample in response to excitation energy applied thereto and to average the signal over a plurality of measurements to generate an averaged signal, or a data processing system including a noise-reduction pre-processor configured to create a vector space from the averaged signal and to generate singular values and eigenvectors of a correlation matrix constructed within the vector space, or a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value so as to request the data acquisition system to perform additional measurements if no such separation can be identified, or a control system

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configured to prevent further measurements from being made by the data acquisition system if the appearance and stability of the gap can be established.

Broomhead also does not teach or suggest an apparatus for performing spectral analysis that has a data processing system including a noise-reduction pre-processor configured to create from an averaged signal a vector space that contains a noisefree signal subspace and a noise subspace, and configured to generate singular values of a correlation matrix constructed within the vector space, where the singular values include noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace.

Izatt

Izatt relates to optical coherence tomography, i.e. generating cross-sectional images of an object (e.g. tissue) from light that is back-scattered from the object, and in particular to coherent backscatter spectroscopy.

Izatt does not teach or suggest at least the above-identified limitations (1), (2), and (3) of claim 1, which were discussed above in conjunction with Worley, and which are reproduced below:

(1)   a data processing system including: a noise-reduction pre-processor configured to create a vector space from said averaged signal,

(2)   and to generate one or more singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space;

(3)   a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.

In addition, Izatt does not teach or suggest that the vector space contain a noisefree signal subspace and a noise subspace, nor does Izatt teach or suggest that the singular values include noisefree singular values associated with the noisefree signal subspace and noise singular values associated with the noise subspace.

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Regarding above-identified limitations (1) and (2), Izatt does not teach, suggest, or even relate to these limitations. The Examiner also does not state anywhere that Izatt discloses any of the above-identified elements (1) and (2) of claim 1.

Regarding above-identified limitation (3), the Examiner quoted col. 18, lines 9-14 of Izatt, and stated as follows: *". . . Izatt et al. teaches a control system that requests or prevents the data acquisition system to perform additional measurements (col. 18, lines 9-14)."* Office Action page 3. Applicant notes that above-identified limitation (3) of claim 1 recites a control system that is configured to identify a gap between a noisefree singular value and an adjacent noise singular value, to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of the gap can be established, none of which is taught or suggested by col. 18 lines 9-14 of Izatt, or anywhere else in Izatt.

Col. 18, lines 9-14 of Izatt, quoted by the Examiner, states: *"As indicated in step 35a, it is determined whether a sufficient number of cross correlation functions have been acquired; and as indicated in step 36, if more data is needed, the distribution of scatterers within the sample is altered or the sample arm is slightly repositioned prior to returning to step 33."*

As seen from the quotation above, col. 18, lines 9-14 of Izatt does not disclose, or have anything to do with, identifying a gap between a noisefree singular value and an adjacent noise singular value, requesting a data acquisition system to perform additional measurements if no such separation can be identified, and preventing further measurements from being made by the data acquisition system if the appearance and stability of the gap can be established. Rather, as seen from the quotation above, col. 6 lines 11-18 of Izatt discusses acquiring cross-correlation functions, determining whether a sufficient number of cross-correlation functions have been acquired, and altering the distribution of scatterers within a sample or slightly repositioning a sample arm if more data is needed. This is completely unrelated to element (3) of claim 1.

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Combination of Worley, Broomhead, and Izatt

Because both Worley and Izatt do not teach or suggest at least the above-identified elements (1), (2), and (3) of claim 1, and Broomhead does not teach or suggest any of the elements of claim 1, it follows that the combination of Worley, Broomhead, and Izatt does not teach or suggest at least the above-identified elements (1), (2), and (3) of claim 1.

Accordingly, the proposed combination of Worley, Broomhead and Izatt is not a proper basis for an obviousness of rejection of claim 1, since the proposed combination of Worley, Broomhead, and Izatt does not teach all the elements of claim 1.

B. There is no Suggestion, Teaching, or Motivation to Combine the Documents (Worley, Broomhead, and Izatt) on which the Examiner's Rejection is Based

Applicant submits that, not only does the proposed combination of Worley, Broomhead, and Izatt fail to teach or suggest all the limitations of claim 1, but also there is no suggestion within the cited documents (Worley, Broomhead, and Izatt) of any desirability of making such a combination, nor is there any teaching motivation for such a combination.

It is well established that the Examiner must provide some suggestion of the desirability of doing what the inventor has done, without the benefits of impermissible hindsight. See MPEP 2142 and In Re San Su Lee, 277 F.3d at 1338: "*The initial burden is on the Examiner to provide some suggestion of the desirability of doing what the inventor has done.*" The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). See MPEP 2143.01. It is also well established that, in order for a *prima facie* case of obviousness to be established, the teaching or suggestion to make the claimed combination must be found in the prior art itself, and not based on applicant's disclosure. In Re San Su Lee, 277 F.3d 1338 (CAFC 2002) ("[T]*he evidence of record must identify an objective source of the motivation to combine A with B in the manner proposed.*") See also MPEP §§2141-2142.

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Applicant submits that nothing in Worley and/or Broomhead and/or Izatt suggests the desirability of combining Worley, Broomhead, and Izatt in the manner proposed, nor is any motivation for the proposed combination found in Worley and/or Broomhead and/or Izatt. Applicant further submits that, even if the documents (Worley and Broomhead and Izatt) were so combined, the proposed combination would not teach or suggest all the elements of claim 1, as explained above.

For all the reasons discussed above, Applicant submits that the Examiner has not established a *prima facie* case of obviousness, and that there is no proper basis for the 35 U.S.C. § 103 rejection of independent claim 1. Applicant respectfully submits that independent claim 1 is allowable.

Claims 2 and 4-8

It is well known that "[i]f an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious." MPEP 2143.03; In re Fine, 837 F.2d 1071, 2 USPQ2s 1596 (Fed. Cir. 1988).

Claims 2 and 4-8 depend on claim 1, and therefore include all the limitations of claim 1. For all the reasons discussed above, claim 1 is nonobvious under 35 U.S.C. § 103 over Worley, Broomhead, and Izatt. It follows that claims 2 and 4-8 (all depending from claim 1) are also nonobvious under 35 U.S.C. §103.

For these reasons, Applicant respectfully submits that claims 2 and 4-8 are allowable.

5. Rejection of Claims 9-13 Under 35 U.S.C. § 103(a)

Claims 9-13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Worley, Broomhead, and Izatt, as applied to claims 1, 2, and 4-8 above, and further in view of U.S. Patent Application Publication No. 10/660,713 to Trickett et al. ("Trickett").

For all the reasons set forth in section 4 above, and in particular because the combination of Worley, Broomhead, and Izatt does not teach or suggest at least the

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above-identified limitations (1), (2), and (3) of claim 1, claim 1 is not obvious under 35 U.S.C. § 103 over Worley, Broomhead, and Izatt, as discussed in detail above.

Claims 9-13 depend on claim 1, and therefore include all the limitations of claim 1. It follows that claims 9-13 (all depending from claim 1) also are not obvious under 35 U.S.C. §103 over Worley, Broomhead and Izatt.

As for Trickett, in addition, Trickett teaches noise reduction in seismic data (see e.g. Trickett paragraph [0001] *"The present invention relates generally to processing seismic data and particularly to reducing noise in seismic data using a variety of 3D eigen filtering techniques based on matrix rank reduction in the frequency domain"*). Trickett does not teach or suggest, or relate to, any of the limitations of claim 1, including but not limited to limitations (1), (2) and (3) discussed above. The Examiner also does not state anywhere that Trickett teaches any of the limitations of claim 1.

Applicant submits that, since Trickett does not teach any of the limitations of claim 1, the combination of Worley, Broomhead, Izatt, and Trickett also does not teach or suggest at least the above-identified limitations (1), (2), and (3) of claim 1, and therefore that claims 9-13 (which depend on claim 1 and therefore include all the limitations of claim 1) are not obvious under 35 U.S.C. § 103 over Worley, Broomhead, Izatt, and Trickett.

In addition, regarding Trickett, the Examiner states as follows:

"The application of Trickett teaches a method of noise reduction using matrix rank reduction. Trickett does not teach a system that uses averaged signals, however Worley et al. specifically teaches that averaged NMR transients are used as an input to the system. It is inherent that the decimated data points have a smaller signal length and a sampling period greater than the input sampling frequency. It would have been obvious to one of ordinary skill in the art to combine these teachings, in order to reduce the amount of time involved in processing the data (Trickett, paragraph 17, lines 3-6)." Office Action, pages 7-8.

Applicant submits that Trickett, which (as acknowledged by the Examiner) teaches noise reduction using matrix rank reduction, does not teach or suggest a

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windowing subsystem configured to apply a windowing filter to a Fourier transform of the averaged signal so as to generate decimated signals having a limited bandwidth, as recited in claim 9, nor does Trickett teach or suggest storing the inverse Fourier transform of each decimated signal as a set of decimated data points, as recited in claim 10, nor does Trickett teach or suggest storing M-dimensional vectors in a form given by $c_n^d = (c_n^d, c_{n+1}^d, \ldots, c_{n+M-1}^d)$, where c_n^d represent the decimated data points, as recited in claim 11, nor does Trickett teach or suggest forming the correlation matrix from the M-dimensional vectors, as recited in claim 12, nor does Trickett teach or suggest projecting the averaged signal based on a projection formula given by

$$\vec{c}_n^{nr} = \sum_{k=1}^{K} (\vec{u}_k^*, \vec{c}_n)\vec{u}_k \text{ , as recited in claim 13.}$$

Applicant therefore submits that not only does Trickett fail to disclose all of the elements of independent claim 1 (from which claims 9-13 depend), but also Trickett fails to disclose the additional limitations recited in claims 9-13 depending from claim 1.

For all of these reasons, Applicant submits that claims 9-13 are allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Broomhead, Izatt and Trickett.

6.   Rejection of Claims 3, and 14-24 Under 35 U.S.C. § 103(a)

Claims 3 and 14-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Worley, Broomhead, and Izatt, as applied to claim 1, and further in view of U.S. Pat. No. 5,148,522 to Okazaki. Applicant respectfully traverses these rejections.

Claim 3

Claim 3, which depends on claim 1 and therefore includes all of the limitations of claim 1, is not obvious under 35 U.S.C. § 103(a) over Worley, Broomhead, and Izatt, as explained in detail above.

Regarding Okazaki, Okazaki is directed to an information retrieval apparatus, and is not relevant to claim 3, because Okazaki does not teach or suggest any element of claim 3. In particular, Okazaki does not teach or suggest any pattern recognition

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system adapted to identify a gap between a noisefree singular value and an adjacent noise singular value, in a plot of singular values, as recited in claim 3.

Furthermore, Okazaki, which discloses *"an information retrieval apparatus"* and *"an information retrieval interface for handling requests for retrieving two-dimensional information"* (see e.g. Okazaki Col. 1, lines 15-20), does not teach or suggest any element of any of Applicant's claims.

The Examiner states: *". . . Okazaki teaches that the system can be configured to recognize retrieval conditions (col. 2, lines 7-18)."* Office Action page 10. Applicant notes that "recognizing retrieval conditions" is not recited in any of Applicant's claims, including claim 3, and therefore that this statement by the Examiner is irrelevant in analyzing Applicant's claims, including claim 3.

The Examiner further states: *"It would have been obvious to one of ordinary skill in the art to combine these teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki. These systems when combined would shorten the length of time needed to acquire signals of interest."* Office Action page 10. Applicant notes that "shortening the length of time needed to acquire signals of interest" is not recited in Applicant's claim 3, and therefore that this statement by the Examiner is irrelevant in analyzing claim 3.

For these reasons, Applicant submits that not only does Okazaki fail to disclose all of the elements of independent claim 1 (from which claim 3 depends), but also Okazaki fails to disclose the additional limitations recited in claim 3 depending from claim 1. Applicant therefore submits that claim 3 is allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Broomhead, Izatt and Okazaki.

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Claims 14-19, 21, and 24

The Examiner states:

"Regarding independent claims 14-19, 21, and 24, see the rejections of claims 1-5. It would have been obvious to one of ordinary skill in the art to combine the teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki in order to reduce noise and shorten processing time." Office Action pages 10-11. Applicant notes that "reducing noise and shortening processing time" is not recited in any of Applicant's claims, including claims 14-19, 21, and 24, and therefore that this statement by the Examiner is irrelevant in analyzing Applicant's claims, including Applicant's claims 14-19, 21, and 24.

For reasons explained above in conjunction with, *inter alia*, claims 1-5, the combination of Worley, Broomhead, and Izatt fails to teach or suggest all of the limitations of claims 14-19, 21, and 24. Because Ozakazi fails to teach or suggest any limitation of any of Applicant's claims, as explained above, it follows that the combination of Worley, Broomhead, Izatt, and Ozakazi also fails to teach or suggest all of the limitations of claim 14-19, 21, and 24.

In particular, for reasons explained above, the combination of Worley, Broomhead, Izatt, and Ozakazi fails to teach or suggest at least the following limitations of claims 14-19, 21, and 24: elements a and b of claim 14; element a of claim 15; element c of claim 16; elements b, c, d, and e of claim 17; elements b, c, d of claim 18, elements c, d, e of claim 19, elements a, b, c, and d of claim 21, and elements f, g, h, i, and j of claim 24.

It goes without saying that no motivation can be found in Worley and/or Broomhead and/or Izatt and/or Okazaki to combine the documents (Worley, Broomhead, Izatt, Okazaki) in the proposed manner.

For all of these reasons, Applicant submits that claims 14-19, 21, and 24 are allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Broomhead, Izatt and Okazaki.

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7. Conclusion

On the basis of the foregoing amendments, Applicant respectfully submits that all of the pending claims 1-24 are in condition for allowance. An early and favorable action is therefore earnestly solicited.

The Commissioner is authorized to charge Deposit Account No. 501946 for payment of any additional fees required by this response or to credit any overpayment to the account, and reference attorney docket no. 28080-119-6806.. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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